Bundeswehr Transformation Center
Concept Development & Experimentation Division
Concept Development Branch

Knowledge Development Generic Framework Concept Draft

This is the final MNE 5 document on Knowledge Development.

Contact ZTransfBw Abt II CDE@bundeswehr.org for inquiries regarding subsequent updates beyond MNE 5 efforts.

VERSION 1.30
18. December 2008

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
18 DEC 2008	**Final**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Knowledge Development Generic Framework Concept	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Bundeswehr Transformation Center, Concept Development & Experimentation Division, Concept Development Branch**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) **USJFCOM J9 Joint Concept Development and Experimentation, Suffolk, VA**	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

The aim of this concept is to provide the theoretical and generic basis for Knowledge Development (KD) in support of future operations. KD contributes to operations by creating a comprehensive and systemic understanding of the operational environment. The proposed generic approach will provide ample opportunities for testing and evaluation through the whole spectrum of CD&E activities. Furthermore it serves as a platform for the involvement of other instruments of influence as well as IO/NGO and GO. The main purpose of this document is to provide the generic framework for KD and initial guidance for future research and testing.

15. SUBJECT TERMS
multinational, experiment, MNE, MNE 5, owledge development, situational awareness, situational understanding, systems analysis

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**48**	

1 Introduction

1.1 Aim

[11000] The aim of this concept is to provide the theoretical and generic basis for Knowledge Development (KD) in support of future operations. KD contributes to operations by creating a comprehensive and systemic understanding of the operational environment. The proposed generic approach will provide ample opportunities for testing and evaluation through the whole spectrum of CD&E[1] activities. Furthermore it serves as a platform for the involvement of other instruments of influence as well as IO/NGO and GO[2].

[11005] This document will be updated throughout the course of national and multinational CD&E activities.

1.2 Purpose

[12000] The main purpose of this document is to provide the generic framework for KD and initial guidance for future research and testing.

[12005] Further purpose of this concept is to

- provide a generic KD process description,
- provide generic ideas for KD implementation,
- facilitate a common understanding of KD related terms, and
- derive requirements for KD CONOPS[3] development.

1.3 Problem Statement

[13000] Joint and combined forces and their non-military partners lack integrated methods, processes, structures, and technologies to gain and maintain common Situational Awareness and Situational Understanding (SA/SU) of the operational environment based on a comprehensive and systemic understanding of the operational setting in a multinational and interagency context.

- The operational environment has evolved as a highly complex, dynamic, volatile, and adaptive system.
- New actors – both governmental and non governmental – are often involved without a clear characteristic whether they should be regarded as opposed, neutral or allied and without definition of their interests, motivations, and capabilities.
- New risks of military as well as non-military nature arise.

1.4 Scope

[14000] KD supports SA/SU throughout the entire spectrum of political – military acting. In the context of current and future operations, a full integration of military and non-military partners in all phases is crucial. KD is especially well suited to support the political and military – strategic as well as the operational level. It can also be used, to a somewhat lesser degree, on the tactical level.

[1] Concept Development and Experimentation (CD&E)
[2] International Organisation (IO), Governmental Organisation (GO), Non-Governmental Organisation (NGO)
[3] Concept of Operations (CONOPS)

1.5 Approach

[15000] KD provides compatible, integrated methods, processes, structures, and technologies to enable commanders, their staffs, and civilian partners to gain a comprehensive and systemic understanding of the operational environment in order to support a Comprehensive Approach (CA) in a multinational and interagency context.

[15005] KD is a process that facilitates the acquisition, exchange, and integration of knowledge from various sources in an effort to enable more effective conduct of operations. It is a continuous, adaptive, and networked activity that helps commanders and their staffs gain SA/SU of the operational environment by describing and modelling the composition, context, and functionality of that environment. Systems Analysis is the centerpiece and core process of KD.

[15010] KD is a supporting capability for use in military functional areas or staff branches and respective processes of non-military partners. It does not substitute or compete with other operational activities but integrates their results.

1.6 Expected Gain

[16000] The conceptual approach to KD will provide significant advantages in gaining and maintaining SA/SU compared to currently existent methods and processes.

1.6.1 Improved Situational Awareness and Understanding

[16005] SA/SU are the human perception of the elements of the operational environment in the context of forces, space and time, the comprehension of their meaning, and the projection of their status in the near future.

[16010] Improved SA/SU provide a common, improved foundation for analysis, planning, execution/management and assessment/evaluation of operations, including their related processes and structures among military and non-military partners.

[16015] The application of KD overcomes the one-dimensional cause and effect thinking. Non-linear thinking “out of the box” and a systemic evaluation of all relevant factors within the operational environment results in a new quality of SA/SU.

[16020] KD facilitates a broader, more interconnected view on the operational environment. Based on a systemic methodology, the clarity of interrelationships between all relevant actors and issues with regard to power and influence is significantly enhanced. Consequently a new quality of analysis results represents an improved holistic understanding of the operational environment.

[16025] SA/SU are closely connected to the evolution of the operational environment over time. KD represents the institutionalization of considering change over time. Consequently KD facilitates more valid predictions of changes in the operational environment and their effects on own operations.

1.6.2 Improved Quality of Operations

[16030] Comprehensive SA/SU provide a broad foundation for any kind of decisions on all echelons of command and across the whole spectrum of operations. Far beyond other methods and processes, KD supports the development of own courses of action: It discovers the dynamics of the problem space, finds causes for certain developments, unveils consequences of certain actions, direct or indirect, and determines the probabilities of action

chains, thus providing much of the information and knowledge useful to or needed by the planner in designing courses of action for the own mission.

[16035] KD helps to integrate all instruments of influence into an overall operation by supporting a common SA/SU amongst all actors. Accordingly the quality of operations is enhanced.

[16040] KD, as a force multiplier, provides advice to operational personnel. It enhances the harmonization of efforts of all instruments of influence while avoiding duplications and conflicts, thus bringing their specific capabilities to bear where appropriate and most valuable. From the spectrum of all available instruments of influence, the best suitable can be chosen. This allows for the maximum possible use of synergistic effects, hence permitting the substitution of scarce resources by equivalent means and assets.

2 Fundamentals

2.1 Operational Context

2.1.1 Spectrum of Operations

[21000] Over the past decade, the scope of conflicts and crises has shifted from the traditional attrition-driven type of warfare in a symmetrical context to a wide range of asymmetrical conflicts and challenges. Along with this fact the attitudes and behaviour of non-state actors, be it terrorist organisations or organized crime on one side, be it e.g. transnational companies on the other side, gain ever more importance. Moreover the political framework is challenged by a variety of non-military risks. Radical nationalism, religious fundamentalism, migration, failing states, proliferation of Weapons of Mass Destruction (WMD), deteriorating demographic developments, international terrorism and resource conflicts result in a growing degree of instability. Due to these non-military risks in particular, the holistic approach is imperative in current and future operations.

[21005] Operations will most likely be conducted in a civil-military framework of existing international organizations or in ad hoc coalitions. Military engagements are considered as only one instrument of influence in a CA[4] to crisis management, and the tasking of military forces in general is likely to continue shifting towards civil actions.

[21010] Political, civil and economic efforts may be more effective to terminate emerging threats than military actions. However, if military action is required, it must be more responsive and discriminating, capable of achieving desired effects. These effects will be obtained via a wide range of capabilities, including kinetic and non-kinetic, lethal and non lethal actions against selective targets that have a high probability of success and result in fewer casualties and less collateral damage.

[21015] In the context of this complexity, actors in future operations will require a comprehensive and systemic SA/SU of the operational environment. Consequently methods, processes, organizations, and technologies have to be developed to meet these requirements.

[4] Campaign Assessment (CA)

2.2 Systems Approach

[22000] KD is a function that applies Systems Analysis to generate and enable explicit knowledge of the operational environment in order to improve SA/SU in support of a Comprehensive Approach in a multinational and interagency context.

[22005] Systems Analysis is a method which defines a network of elements, their relations and interactions, evolving in space and time and thus allows a valid contextual assessment of objectives, sequences of effects and chains of actions. The result of Systems Analysis is a comprehensive modelling of the operational environment with its system dynamics and feedback loops. Systems Analysis will provide a description of intended effects and will expose both intended and unintended consequences.

[22010] The operational environment is described in varying degrees of complexity via this model. Its complexity is directly dependent on the analytical requirements driving levels of fidelity to the real world situation – the higher the required fidelity, the more complex the model. The boundaries of the operational environment to be modelled and the level of modelling detail depend on the analytical requirements. The conceptual model serves as a communication interface among analysts, military staff, and other actors involved

[22015] Systems Analysis will utilise various existing models, methods, and techniques to model and explore the system in its dynamics. Although no single model or method will sufficiently cover all aspects, the application of specific models will facilitate a systemic view on the operational environment. Relevant candidate models may be found in several scientific areas, to include: operations research, cognitive modelling[5], social, natural and economic sciences, social and technical network analysis, command and control assessment, human behaviour representation, risk assessment, information dissemination, and ethnology.

[22020] The KD process

- contributes to and receives value from basic staff activities such as personnel, intelligence, operations command & control, logistics, plans & policy, CIS[6], training & exercise, budget and finance, CIMIC, LEGAD, POLAD[7] etc. without interfering with original responsibilities,
- utilizes linkages between national and multinational partners/agencies, Centers of Excellence (COEs), Subject Matter Experts (SMEs), and the Head Quarter's (HQ) staff. It strives to take advantage of relevant information and knowledge from all available (open and classified) sources of expertise,
- contributes to a MN KB[8] that contains the information necessary for Systems Analysis and other use. The results of Systems Analysis and other assessment are continuously fed back into the MN KB. It is continuously updated by and accessible to the customers (non-military and military actors and their supporting staff), and
- facilitates a broader, more interconnected view on the operational environment. Based on a systemic methodology, the clarity of interrelationships between all relevant actors and issues with regard to power and influence is significantly enhanced. Consequently a new quality of analysis results represents an improved holistic understanding of the operational environment. Improved SA/SU provides a common, improved foundation for analysis, planning, execution/management and assessment/evaluation of operations,

[5] E.g. mental models for decision making, individual or shared sense making
[6] … (CIS)
[7] Civil Military Cooperation (CIMIC), Legal Advisor (LEGAD), Political Advisor (POLAD)
[8] Multinational Knowledge Base (MN KB)

including their related processes and structures among military and non military partners.

2.2.1 Generic Guidance for Continuous Systems Analysis (CSA)

[22025] CSA shall be conducted by System Analysts who act in the sense of generalists. To view the system as a whole before going astray in details is most important. Integrated and interdisciplinary CSA teams facilitate the synthesis of the respective analysts and SMEs that results in the conceptual model of the operational environment.

[22030] Basic staff activities, such as personnel, intelligence, operations command & control, logistics, plans & policy, CIS, training & exercise, budget & finance, CIMIC, LEGAD, POLAD etc. contribute to KD without KD interfering with their original responsibilities.

2.2.1.1 Prerequisites for Continuous Systems Analysis

[22035] The KD process is driven by the timelines and information requirements set by the supported commander, it is coordinated within the overall staff routine and the review of available sources of information. The result will be represented in a proper information collection strategy and directives and guidance for the performance of Systems Analysis.

2.2.1.2 Examination of Customer's Goal System

[22040] The examination of the customer's goal system is an important basis for the directive and guidance for the KD process. Inputs for this analysis include the Strategic End State and the strategic objectives as agreed by the member nations of a coalition or alliance as well as the review of higher authorities' guidance. On the implementation level of KD, the mission analysis of the customer's organization and the respective commander's guidance are subject to the examination. The result of this analysis will coerce KD in a certain direction, provide orientation, and focus the KD process.

[22045] In order to identify and meet the customer's requirements for relevant knowledge, a permanent link between KD and the supported organization is mandatory.

2.2.1.3 Analysis of Initial Knowledge Requirements

[22050] A first look at available information sources will give the KD staff an overview of the currently available knowledge with respect to the operational environment. In close coordination with the Systems Analysts a rough identification of knowledge gaps and obvious demands for more knowledge (information, data) takes place and triggers the KD process. In parallel the examination of potential knowledge providers' release policies occurs.

[22055] In accordance with the battle rhythm, the time available for providing first outputs is evaluated. The result will indicate whether any knowledge integrating activities will have to be curtailed or run concurrently with other processes.

[22060] This analysis will result in a first overview of the currently available knowledge, including knowledge gaps. An integrated list of knowledge requirements as a basis for the information collection strategy concludes this step.

2.2.1.4 Structured Thought Processes

[22065] Structured thought processes can be useful to facilitate the Systems Analysis. In order to highlight different perspectives and views on the same system, the System Analysts should use various generic models to structure their analysis. These models should be

developed in a close dialogue between the System Analysts and the other actors involved. Feasible ways for structuring Systems Analysis include, amongst others, actor centric, subsystem centric, structure oriented, and functionality oriented options. However, this approach carries the danger of stove piped results. System Analysts should be aware of this danger and act in the sense of generalists with special regard to the synthesis of their respective results.

[22070] The PMESII[9] construct is one possible way to structure an operational environment for analysis purposes. Applying the PMESII construct can be useful to facilitate the involvement of functional experts, however it bears limitations. It is paramount to understand that the PMESII construct does not describe mutually distinct/disjoint analysis areas. In other words, the PMESII domains do not stand alone without common elements. Rather, these domains together form the analysis spectrum as a whole.

[22075] A system of mission tailored views on the operational environment evolves from the customer's goal system as well as from the first sketch of the operational environment. The result is a structure for the performance of KD. The relevant views serve as a structure for collection and processing of information.

[22080] Relevant views have to be actor or system element centric in order to reflect the variety of possible views and objectives of the driving elements in the respective systems within the operational environment. The problem of incomplete, uncertain or contradictory knowledge, information, and data has to be addressed by determining the assumptions necessary for abstraction, simplification, and handling.

2.2.1.5 Information Relationships Identification and Establishment

[22085] Systems Analysis requires objective driven input provided by various sources of knowledge, including non-military partners with their specific expertise and views.

[22090] The review of relevant sources of information is a continuous process aimed at utilizing those sources that meet the specific knowledge requirements in the context of the operation.

[22095] Identification of information sources has to reflect on all relevant issues of reliability, probability and security.

2.2.1.5.1 Networking

[22100] Systems Analysis requires a flexible, collaborative, interdisciplinary expert network in terms of relationships and linkages with appropriate external organizations, SMEs, and Centers of Excellence (CoE). Concerning the broad scope of KD, an involvement of such knowledge providers will be required to facilitate the whole spectrum of Systems Analysis.

[22105] Expert network cooperation is not intended to be unidirectional. The System Analysts should provide their assessments to other analysts and relevant personnel in order to contribute to the product validation process. They should also solicit different views and opinions in an effort to reach improved assessments.

2.2.1.5.2 Research Activities

[22110] Intensive research activities to support Systems Analysis are required. These will include empirical studies to:

[9] Poitical, Military, Economic, Social, Infrastructure and Information (PMESII)

- better understand cause and effect relationships for systems activities and related consequences,
- identify transferable lessons learned, and
- prepare Modelling & Simulation (M & S) tools based on accepted scientific insights.

2.2.2 System Fundamentals

[22115] A system in the context of KD consists of interrelated components/elements constituting a combined, dynamic entity. It may be composed of subsystems again. System elements are subsystems not further decomposed for the purpose of analysis. Thus, the system classification as a system, a subsystem, or a system element depends upon the analytical viewpoint and level of abstraction. The individual dynamic behavior can not be concluded, if the analysis is based merely on the individual system properties.

[22120] Current as well as future operations confront the actor with problems since he/she has to understand, decide and act within complex operational environments. In the KD context a workable definition of the system therefore has to concentrate on those characteristics and parameters which most likely influence, impede or even thwart these activities.

[22125] In a first attempt, systems are described by their elements and the relations between these elements. These components usually do not fully characterize a system, their interactions create further new characteristics which cannot be derived from the isolated static analysis of elements and relations alone. This phenomenon is called "Emergence" and must be seen as one of the most essential, if not the main characteristic of a complex system: its dynamic behavior.

[22130] The elements of the systems to be considered in the KD context are typically tightly coupled and thereby produce various feedback loops resulting in non-linearity. Together with actors within the system permanently changing, varying, and optimizing their behaviour according to the actual circumstances, thus intensifying the system’s ability to adapt to changing situations, this results in so-called counter-intuitivity and policy resistance. Systems apparently resist certain actions or strategies, behave against expectations, or develop undesired effects. This often reflects in the fact that short or medium term deterioration may lead to long term improvements, while short term improvements possibly will lead to long term, sometimes irreversible, deterioration.

[22135] System history has to be considered as a given setup for the Systems Analysis of the operational environment.

[22140] Finally, deciding and acting in complex systems is characterized by permanent trade offs between occasionally contradictory goals and objectives.

2.2.3 Systems of Relevance for Knowledge Development

[22145] The dynamic nature of the operational environment confronts System Analysts with the problem to durably identify the relevant systems and subsystems. Not all systems composing the operational environment offer leverage points for influencing the overall system. Therefore the relevant systems and their properties have to be identified in a successive approach to reality.

[22150] The operational context as well as the desired End State of the operation drives the identification of relevant systems. By studying the relevant systems, KD unveils possibilities to affect capabilities and behavior of systems.

[22155] The following description of systems is provided to guide analysts as well as planners, operators, assessors and other personnel involved regarding the factors that need to be systematically considered and understood.

[22160] Systems within the focus of KD are socio-technical systems.

2.2.3.1 Socio-technical Systems

[22170] Socio-technical systems are defined as a unit of human actors as well as facilities structured in a specific order and directed towards achieving a specific result.

[22175] Human actors' behavior, which is the driving factor in socio-technical systems, is less predictable than behavior of technical or environmental systems since it depends upon psychological predispositions, socio-cultural, and environmental factors. Mental models and actions of individuals, groups, and organizations are guided, amongst others, by underlying structures in the social system such as cultural and religious aspects. These factors need to be explored to understand the entire socio-technical system under consideration in a systemic manner.

[22180] From the KD perspective, actors are individuals, groups and organizations associated with the operational environment. They follow objectives and create effects.

[22185] From the KD perspective, a facility is defined as an item that is built, installed or established to serve some particular purpose and is identified by the service it provides rather than by its content. In effect, this means that virtually anything man-made is defined as a facility. Infrastructure is of special relevance in the KD context. It designates all long-lived basic mechanisms of material and institutional kind, which guarantee the functioning of a complex community.

2.2.3.2 Environmental Systems

[22190] Another relevant type of system covers environmental or natural systems.

[22195] Environmental systems are defined as the dimension of an operational environment that is not man-made. KD focuses especially on geographical systems to which operational significance is attached. In general, this represents any natural object or configuration of ground or water represented on a map or chart.

2.2.3.3 Other Systems

[22200] Other systems may be considered context dependent. The System Analyst will not be limited in his/her creativity.

3 Knowledge Development Procedures

[30000] Each major activity in the core KD process model contains several discrete process functions. Each function is an essential element of the KD process and provides input or information for the development of knowledge in support of operations conducted in a multinational and interagency context. The functions are interdependent and are to be executed in an iterative manner. The process model depicts the internal relationships between each of the functions in KD. There are numerous cross-functional relationships between these functions and functions in other processes of operations conducted in a multinational and interagency context.

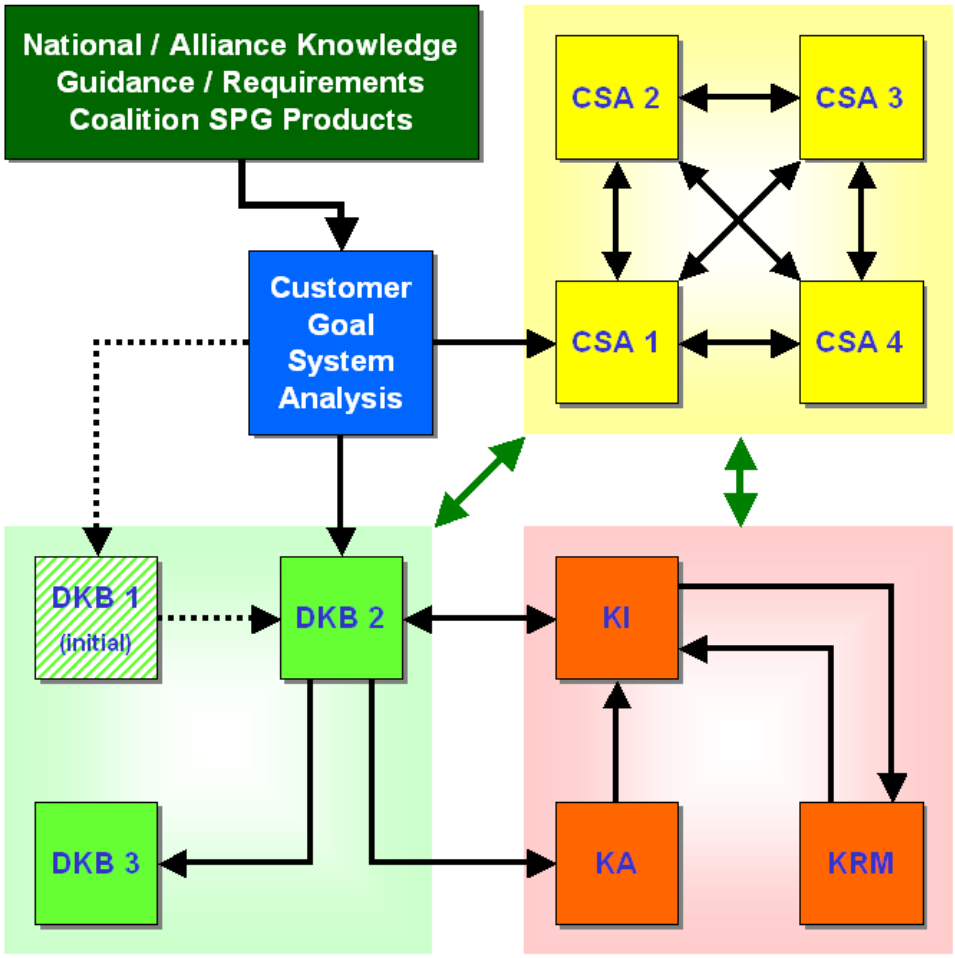

Figure 1: Knowledge Development Process

[30005] The formal multinational KD process is initiated after a coalition is formed. However, preparations have to start as soon as possible. Besides the ever existing restraints, the Multinational Strategic End State and Planning Guidance will shape the input KD receives from available and releasable knowledge repositories of participating nations or coalitions. The provision of knowledge must be based on the requirements of the Systems Approach.

[30010] Implementing procedures for KD require the following activities:

- DKB Development of a Multinational Knowledge Base
- CSA Continuous Systems Analysis
- KP Knowledge Processing

3.1 Development of a Multinational Knowledge Base (DKB)

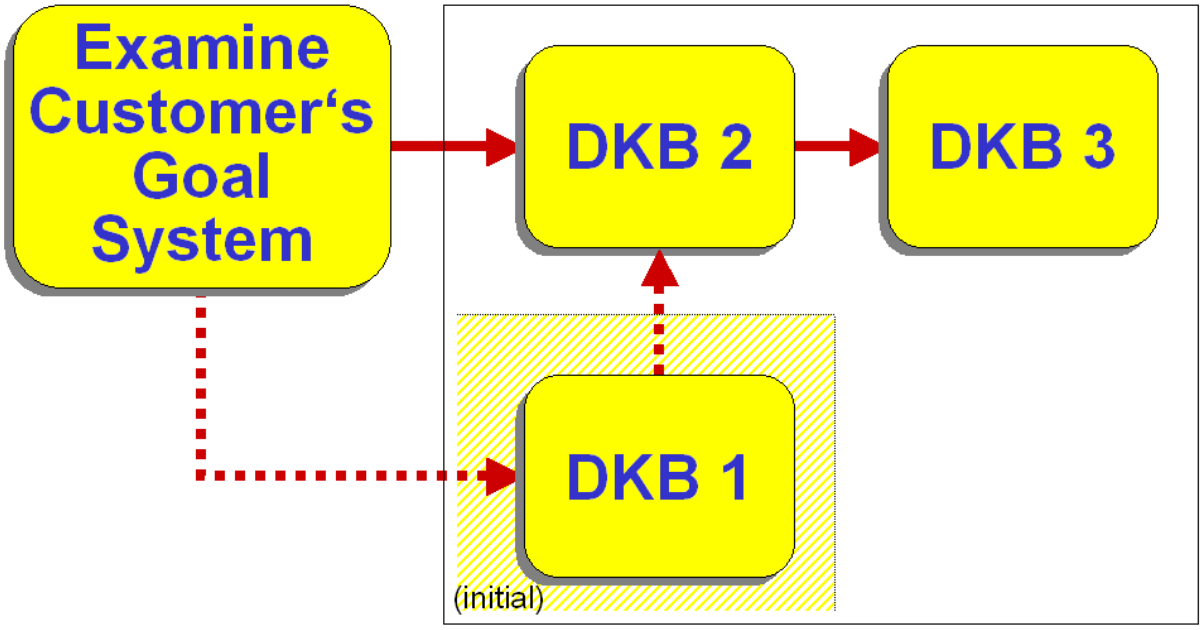

Figure 2: Development of Multinational Knowledge Base

[31000] DKB activity is made up of the following steps:

- DKB 1 Preparation of the Multinational KB (MN KB)
- DKB 2 Building the MN KB
- DKB 3 Access to the MN KB

[31005] A description of each of these discrete steps follows, the relationships between steps are identified in the DKB process model picture above.

3.1.1 Preparation of the MN KB (DKB 1)

3.1.1.1 DKB 1 Purpose

[31010] Purpose of DKB 1 is to create the prerequisites for access to available national and alliance knowledge and other possible sources to build the MN KB. This includes the development of a fundamental two-layered architecture for the MN KB with a first systemic structure, a Knowledge Index (KIndex) and a Knowledge Map (KMap) to be continuously adapted afterwards. The KIndex represents the sum of all currently available knowledge (structure), the KMap states the origin of each knowledge element, keeping track of the knowledge source and residence.

[31015] The architecture will be continuously developed as a derivation of the Systems Analysis work and the analysis of the information or knowledge requirements of other processes within the overall context KD is embedded in. Duplications and redundancies will be initially reduced and filtered.

[31020] DKB 1 will also provide guidance and formulate KD requirements for an external Knowledge Management (KM) function in order to connect all possible external sources.

3.1.1.2 DKB 1 Input

- Customer's goal system
- Available national and alliance knowledge
- Available national and alliance release policies
- Available knowledge from non-military agencies, organizations and institutions
- Overview on how to make the national and alliance KBs accessible
- Prioritized list of information sources (e.g. CoE, SME, RA[10], key papers) as required by KD staff from CSA 1
- Prioritized task list for the integration of data and information into the data management structure
- Additional requests to the KD staff with respect to knowledge gaps and contradictions from CSA 1
- Guidance to KB OpStaff how to integrate (syntactically and technically) the available national, alliance and other knowledge into the MN KB
- Guidance to KB OpStaff how to fuse the available national and alliance release policies to an agreed multinational release policy
- Initial time schedule for DKB activity
- First sketch of systemic structure from CSA 2

3.1.1.3 DKB 1 Procedures

- Organize the access to the available national and other KBs by storing and publishing all input in a structured way until the first MN KB is available
- Set up an initial framework of the MN KB to be refined by further DKB activity
- Determine how to connect the identified sources in close connection with existent knowledge management functions (business rules etc.)
- Create an initial KIndex based on the KIndex of available national, alliance and other KBs and on an initial CSA in cooperation with existing knowledge management functions
- Provide role-based direct access to the MN KB through Collaborative Information Environment (CIE) supported by existing knowledge management functions
- Match the prioritized task list for the integration of data and information with the KIndex
- Create an initial knowledge map based on the knowledge maps of the available national, alliance and other KBs and the first sketch of the systemic structure
- Catch the guidance for integration of the available national and alliance KBs from evaluation of the customer's goal system with the knowledge map
- Continue collection of national or alliance data, information or knowledge contributions
- Conduct initial duplication, redundancy, and reliability filtering among national and alliance knowledge. The KB OpStaff in close cooperation with the System Analysts may apply the following process to gain a coalition agreed assessment from diverging assessments:
  - The KB OpStaff performs a discrepancy analysis in order to identify the divergent nation and alliance assessments.

[10] Regional Advisor (RA)

  - Based on outputs from evaluation of the customer's goal system, particularly the knowledge requirements, the KB OpStaff starts to select the critical discrepancies to be solved (following steps in DKB 2).
- Formulate requirements to existing knowledge management functions in order to set the framework for further process steps

3.1.1.4 DKB 1 Output

- Structured access to the national, alliance and other Knowledge (Bases)
- Role-based direct access to the MN KB through the CIE
- Connecting-plan for the already identified sources
- Updated prioritized task list for data and information integration
- Initial basic MN KB architecture including
  - a first sketch of a systemic structure (from CSA 1 and 2),
  - an initial KIndex for the MN KB, and
  - an initial KMap for the MN KB.
- Integration-plan for available initially reduced and filtered national, alliance and other KBs into KIndex and KMap
- List of requirements to existing knowledge management functions
- List of technical requirements to the CIE personnel
- Continuous national, alliance or other sources data, information or knowledge contributions

3.1.1.5 DKB 1 Staff Participation

- KB OpStaff
- System Analysts
- Representatives of supported organizations

3.1.2 Building the Multinational Knowledge Base (DKB 2)

3.1.2.1 DKB 2 Purpose

[31025] DKB 2 purpose is to feed data, information and knowledge from the initial national, alliance and other KBs into the MN KB following the previous developed KIndex and KMap. Further available inputs will be added to the basic architecture of the MN KB. This can be achieved automatically or semi-automatically by technical measures of data integration or manually.

[31030] After the national, alliance and other KBs are integrated during the first run of DKB 2, the main purpose of DKB 2 is to further build, administer and control the MN KB by putting together the inputs from Knowledge Integration (KI), CSA, and from the interaction with the other processes, projects and organizations.

3.1.2.2 DKB 2 Input

- Prioritized list of the knowledge segments that are required by customer's goal system
- Issues for clarification with higher authority from review of customer's goal system
- Structured access to the national, alliance and other Knowledge (Bases) from DKB 1
- Continuous national, alliance and other sources data, information or knowledge contributions from DKB 1
- Functions to access the MN KB from DKB 1

- Updated prioritized task list for the integration of data and information from DKB 1

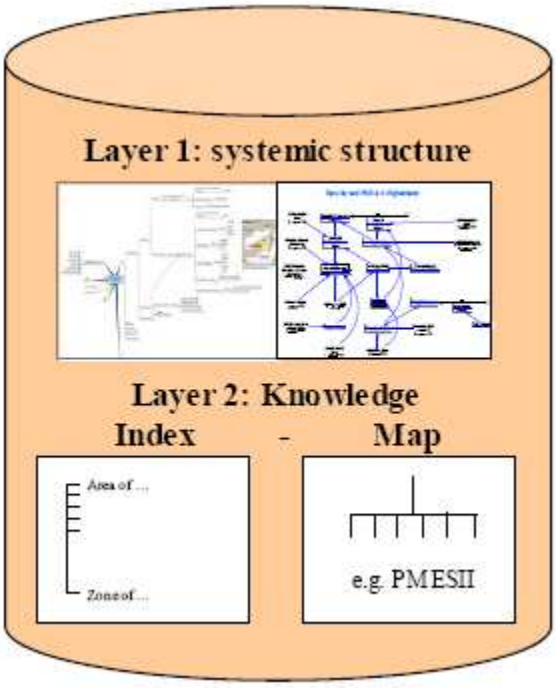

Figure 1 The Fundamental Architecture of a virtual Knowledge Base

- Initial basic architecture of the MN KB with
  - first sketch of systemic structure from CSA 2,
  - initial KIndex for the MN KB from DKB 1, and
  - initial KMap for the MN KB from DKB 1.
- Integration-plan for available national, alliance and other Knowledge Bases from DKB 1 (only required for first run of DKB 2)
- Influence diagrams (actors, actions, resources, influences) including indication of impact, intensity, time behavior of flow rates from CSA 2
- Options for Courses of Action (CoA) for relevant actors, embedded in the system's dynamics from CSA 4
- Corresponding list/matrix with cross references to resource chains and capabilities from CSA 4
- Corresponding lists/matrices containing higher order effects deduced from the influence diagrams and associated with these CoA from CSA 4
- Refinements of influence diagrams, causal and cognitive maps
- CoA – sets: sets of actions, partially ordered, linked to diagrams and maps, effects lists, and resource lists
- Properly integrated KB inputs from KI
- Requirements-based integration of KB inputs from KI

3.1.2.3 DKB 2 Procedures

[31035] Continuously transfer the available data, information and knowledge from the national, alliance and other Knowledge (Bases) into the MN KB including the complete elimination of duplications and redundancies and the check of reliability in close cooperation with the CSA activity ("Initial Knowledge Integration").

[31040] During the initial period (first run), the DKB 2 activity ensures that requirements to support the major initial integration effort are addressed. After the integration of the national, alliance and other KBs is completed, the constant process of feeding new input into the MN KB continues and further available input is added to the basic architecture:

- Include raw data, information and assessments into agreed coalition knowledge
- Other related assessments gained through intellectual processes
- Involve actionable knowledge produced in support of the coalition decision-making process, using the Systems Approach

[31045] The updated prioritized task list will set the order for the integration of data and information for the first run of DKB 2. The KB OpStaff, in order to resolve the critical discrepancies between nation, alliance and other sources inputs identified in DKB 1 or on a day-to-day basis, can use the following process:

- In a first attempt to solve these critical discrepancies, the KD staff organizes harmonization efforts (through collaborative sessions, direct contact, etc.) between involved nations, alliance staffs and others, based on its own criteria of assessment.
- If the discrepancies persist, the KB OpStaff proposes its own assessment and/or issues new Knowledge Requests to clarify or check complementary topics.
- The nations, alliance staffs and others review the KD staff assessment.

[31050] The KD SysA assessment and its supporting products are disseminated within the coalition staffs and others as required, along with critical and non resolved disagreements. The KB OpStaff will store or publish all input to the KB, according to the fore mentioned layers. Especially it will

- link the systemic structure with the KIndex/KMap
- incorporate products from the involved processes and projects into the MN KB throughout
- involve additional knowledge products acquired as a result of Systems Analysis into the MN KB in close cooperation with CSA
- store additional available data and information
- publish the systemic structure on the CIE and push the notice of availability to the customers' functions in close coordination with the existing knowledge management functions.

Accessible via CIE are

- systemic structure,
- search engines: links to systemic structure, and
- KIndex connected to the systemic visualization.

3.1.2.4 DKB 2 Output

- MN KB with basic architecture
  - systemic structure from CSA,
  - KIndex, and
  - KMap.
- Search and overview functions
- Merged national, alliance and other Knowledge Bases.

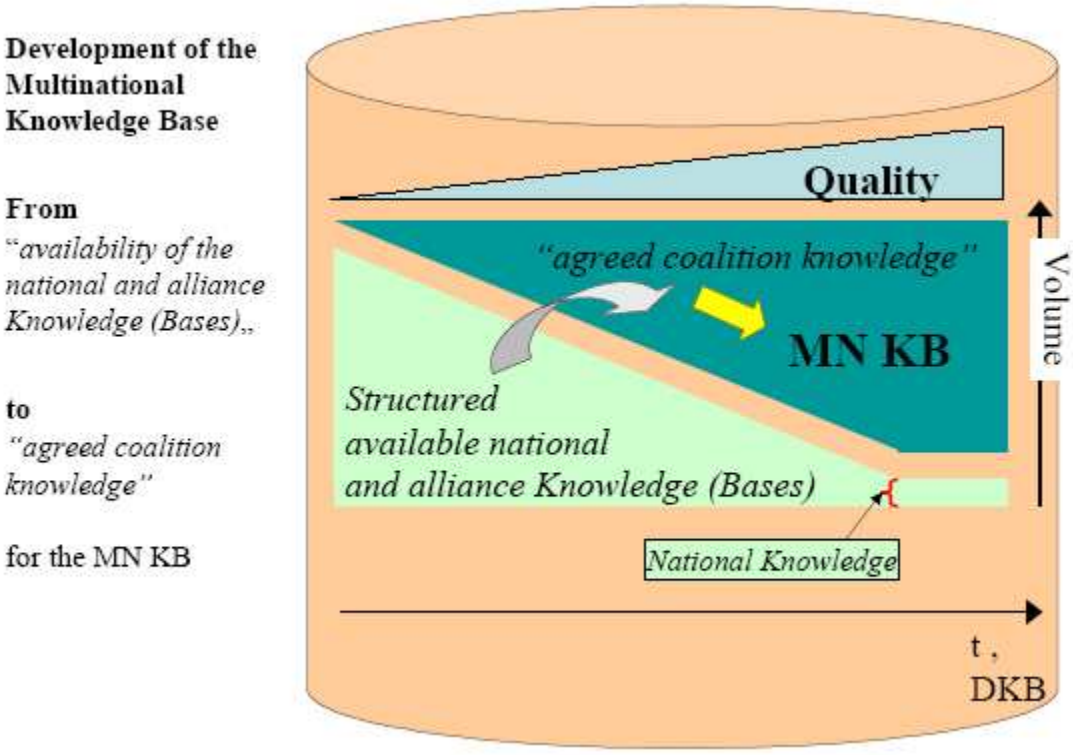

Figure 2 The development of a Multinational Knowledge Base

3.1.2.5 DKB 2 Staff Participation

- KB OpStaff
- System Analysts
- Supported organizations representatives

3.1.3 Access to the Knowledge Base (DKB 3)

3.1.3.1 DKB 3 Purpose

[31055] DKB 3 purpose is to ensure the user ability to gain rapid access to the required available data, information or knowledge elements. Information and knowledge is provided by using the pull/push-principle. Users will set up or identify the type of information and knowledge they require to be forwarded automatically. Dissemination of knowledge links closely to a management of knowledge by integrating existing knowledge management functions. It also influences the portal design, affects visualization and the CIE in accordance with knowledge management basic functions and business rules.

[31060] The intention of this step is the analysis of information and knowledge needs of other processes, projects, agencies and organizations in order to design appropriate interfaces and decide which information and knowledge in which format is to be pushed to the users.

3.1.3.2 DKB 3 Input

- MN KB from DKB 2

3.1.3.3 DKB 3 Procedures

- Assess knowledge requirements of System Analyst and other processes, projects, agencies and organizations involved (in cooperation with users) – in general and actually given by the KR activity
- Assess significance of information/knowledge for the ongoing operation
- Determine the output format - amount, kind, breadth and depth of the information displayed (in cooperation with users)
- Analyze and decide whether it is better to communicate an information object automatically (“document-to-people”) or via human interfacing (“people-to-people”)
- Push immediate and higher precedence messages to the appropriate users
- Continuously interact with KB users in order to react in a most flexible and effective way concerning users requirements
- Prepare and provide visualization of dynamic influence diagrams of the operational environment (push-principle)
- Directly support the users exploration of the KB layer 1 by providing initial or complementary explanations and briefings on how to use the KB and on the substance of knowledge products
- Develop contribution to the Common Relevant Operational Picture (CROP)
- Determine needed update-rates

3.1.3.4 DKB 3 Output

- Easily accessible, comprehensive MN KB that meets the users requirements
- Contribution to CROP
- Contribution to enhanced SA/SU
- Table talk with experts for open questions
- Explanation briefings to users by analysts and SMEs.

3.1.3.5 DKB 3 Staff Participation

- KB OpStaff
- System Analysts
- Supported organizations representatives

3.2 Continuous Systems Analysis (CSA)

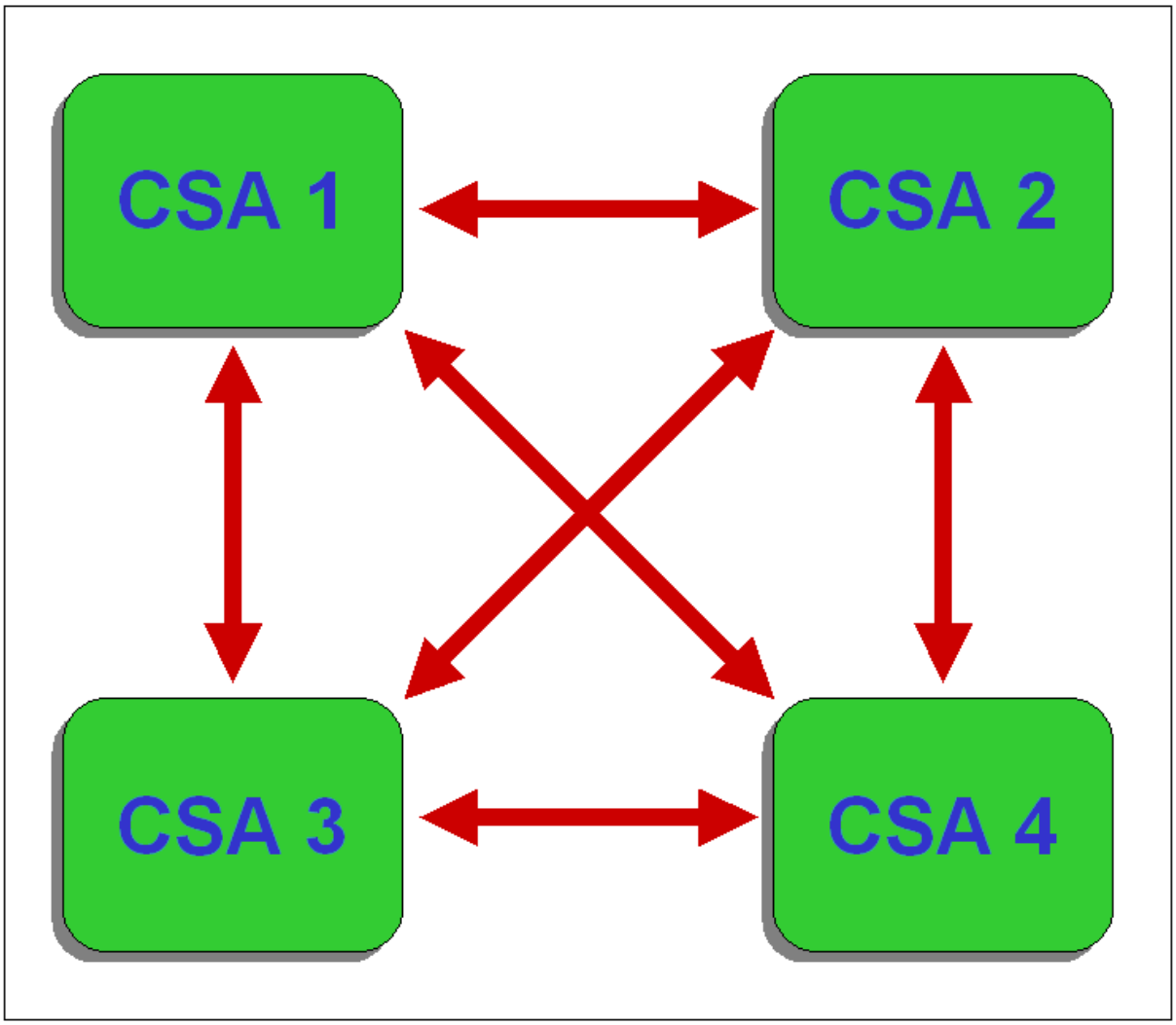

Figure 3: Continuous Systems Analysis

[32000] CSA is made up of the following steps:

- CSA 1 Examine the operational environment
- CSA 2 Model the operational environment
- CSA 3 Examine and simulate possible future system behavior
- CSA 4 Provide Systems Analysis updates for the supported organization:

[32010] A description of each of these discrete steps follows. Refer to the CSA process model in order to see the relationships between steps.

[32015] CSA is a continuous and iterative process. It is permanently creating and acquiring, correcting, refining and accumulating knowledge. Thus it permanently unveils new questions and requests for information on system elements, relations, behavior, actions, dynamics and feedbacks. Moreover, in search for information, advice, and evaluation it continuously expands the community of experts and depth of expertise.

[32020] Execution of CSA, of its different functions, and the results of CSA depend on the problem or task given and on the context and actual situation of the operational environment
Important are the time given or chosen for a particular task ("battle rhythm"), the actors or clients involved in the analysis, the level to which the results should be presented, and the choice of method to be used.

[32025] CSA is working in parallel on different scales:
- short-term tasks and analysis
- long-term research and analysis of the system "operational environment" or "focus area"

The short-term or ad hoc solution of a task profits from resp. is enabled through the knowledge which is accumulated on the longer time scale.

[32030] CSA is a team effort, interactively involving, if possible sponsors and clients. CSA is producing coherent and integrated knowledge through interaction, dialogue and discourse.

[32035] CSA is a methodology or framework, not a single method or a checklist ("recipe book"). CSA is using and taking advantage of algorithms, procedures and methods of different disciplines and domains incorporating quantitative methods like probability theory and statistics as well as the qualitative holistic-hermeneutic research methods of the social sciences, politics and history. It is "transdisciplinary".

[32040] CSA is a flexible, adaptive and reflexive process. Depending on the problem or task and on the actual situation it will require or allow different times spent for and optional combinations of the individual steps of the process.

3.2.1 Examination of the Operational Environment (CSA 1)

3.2.1.1 CSA 1 Purpose

[32100] Purpose of CSA 1 is to give a first broad overview of the operational environment and thereby to determine the scope of the Systems Analysis required to support the provision of SA/SU. CSA 1 already involves all the steps of the subsequent process "en miniature".
The results provide guidance on how to go through the other steps as well as on the scope of the Systems Analysis to be accomplished.
This in mind, depending on problem and situation, the SysA must decide, whether it is possible or even necessary to already conclude the analysis with step CSA 1.

3.2.1.2 CSA 1 Input

- Higher Authority's and Commander's guidance
- Campaign assessment status report when available
- Data and information made available by the participating nations and organizations.
- Interests, ideas and theories available through multiple, mostly public, sources

3.2.1.3 CSA 1 Procedure

- Review input
- Derived from the input CSA 1 starts top-down with a first tentative model or theory of the operational environment.

- Part of this activity is preliminarily setting boundaries for the focus area and a first specification of the meaning of concepts and variables to be used
- Define and validate key actors (Red, Green, and Blue) in the focus area with their
  - interests,
  - interrelationships,
  - historical record, and
  - support networks.
- From a first broad vision of the attitudes, interests and behaviour of the actors determine possible objectives and strategies and their compatibility with the functioning and development of the system "operational environment"
- Determine the main/primary sources of information as well as the secondary ones and rate their reliability
  - Determine theoretical background (politics, international relations, economy, etc.)
  - Determine experience from past activities (lessons learned)
  - Determine methods and tools of key experts, key practitioners and key organisations to explore the operational environment and its main problems and issues
- Incorporate these knowledge, methods and instruments appropriately and flexibly into the analysis
- Engage appropriate representatives from government organizations, IO, NGO, other private sector, and academia, either directly or through a coordination function, in order to gain manifold/different points of view regarding key actors, their objectives and relevant sources of information

3.2.1.4 CSA 1 Output

- Preliminary understanding of the operational environment with its
  - systems boundaries,
  - local, regional and global actors, and
  - possible objectives and strategies.
- Preliminary understanding of the modes of perception and analysis, of methods and theories of relevant actors, either potential or real partners in a coalition, or others
- Decision on the scope of the environment to consider for the further analysis
- A model family and a (methodological and semantical) framework to go on with CSA and to support activities like planning, execution, assessment
- A list of information and knowledge sources (e.g. CoE, SME, Regional Advisor, key papers)
- A plan to engage experts

3.2.1.5 CSA 1 Staff Participation

- System Analysts
- Intelligence
- Representatives of supported organizations

3.2.2 Modelling the Operational Environment (CSA 2)

3.2.2.1 CSA 2 Purpose

[32200] Purpose of CSA 2 is to develop an explicit operationalized representation of the operational environment. The result should be a detailed and defined description of the elements and their interrelationships. Ideally, from CSA 2 one obtains a family of models representing different views of the operational environment at different levels of aggregation formulated in a rather formalized language. This model family is used in the following process steps to analyze possible dynamic system behavior. A coherent picture of the system "operational environment" is developed based on this model. It provides a refined, more formalized framework for description, exploration and explanation of the operational environment.

3.2.2.2 CSA 2 Input

- Preliminary results of the step CSA 1 (compare output CSA 1)

3.2.2.3 CSA 2 Procedures

- Describe the relevant system elements (actors, interests, interrelationships, historical record, support network, …) through concrete operationalized attributes / characteristic parameters.
- Define the relationships between elements through operationalized parameters
- Thus get an at first static picture of the operational environment seen from different domains or disciplines, levels of consideration and objectives given
- Develop or refine hypotheses concerning the possible dynamic behaviour of the system describing actors, actions, resources, effects, including indications of impact, intensity, time behaviour and feedback
- Based on the framework given through step 1 develop or refine different models of the systems "operational environment" in order to represent and analyse these hypotheses
- Thus provide a coherent picture of the system "operational environment" comprising different viewpoints like
  - the domains Politics, Economy, Social, Infrastructure, Information (PMESII),
  - the levels of consideration or analysis: actors, groups, institutions, organisations, system as a whole,
  - cross-domain concepts: stability, security, governance, development.
- Come up with possible attributes, intentions and behaviour of the relevant actors. Give a first analysis of the respective inconsistencies, threats, vulnerabilities and opportunities for the different actors.
- As far as possible these insights or courses of action have to be formulated in the formal, operationalized language of the system models. Part of this language may be e. g. "state descriptions", "influence diagrams" or "stock and flow diagrams".
- This formalization provides the opportunity to apply algorithms, calculus of probability and other methods of Operations Research (OR) or Artificial Intelligence (AI) domains.
- On the other hand CSA 2 has to translate and formulate its models, hypotheses and analysis results in the language (verbal and visual) of the different disciplines, agencies and "users".
- Engagement of appropriate representatives from government organizations, IO, NGO, other private sector, academia, either directly or through a coordination function, in order to gain manifold/different points of view during the conduct of the procedures above, is continued along the lines outlined in step CSA 1.

3.2.2.4 CSA 2 Output

- Model family of the system "operational environment" formulated in a concrete operationalized and, where possible, formal state space description suitable for the algorithmic analysis techniques of the SysAs.
- Model family (framework) of the operational environment, formulated and presented in the languages of the different relevant actors.
- Assessment and representation (e.g. visualization) of attributes, intentions, behaviour of the relevant actors in the operational environment.

3.2.2.5 CSA 2 Staff Participation

- System Analysts
- Intelligence
- Representatives of supported organizations

3.2.3 Examination and Simulation of Future System Behavior (CSA 3)

3.2.3.1 CSA 3 Purpose

[32300] CSA 3 purpose is to deepen and sharpen the understanding of the system "operational environment", to reveal actors' possible future behavior within the operational environment and the reactions of the system thereupon. This is primarily an effort to answer the question "What would happen if…?.". The KD staff will use the bounds provided by the customers' goal system, information requirements from the staff as well as knowledge acquired in the steps CSA 1 and CSA2 from experts and theory to choose specific ways deemed representative and worthwhile to stimulate the models of the operational environment. KD staff will then examine how the environment might evolve over time based on those given, defined stimuli.

[32310] Simulation, in the broadest sense of the word, will be used for this examination. Specific simulation methods will be selected depending on the objectives, the available time and complexity of issues to be examined. Simulation may thus be performed within the full range, from a quick table top war-game to a full-fledged computerized discrete event simulation.

[32320] These simulations of possible future behaviour will provide the KD staff with the operative background knowledge necessary to inform the staff during the planning, execution and assessment phases of a mission, e. g. during the development of Desired End State, CoA, and the assignment of resources. Simulation results may lead to decision-adaptation within the staff and other organizations.

3.2.3.2 CSA 3 Input

- Description of relevant actors including their characteristic parameters from CSA 1 and CSA 2
- Set of influence diagrams, causal loop diagrams and other visualization of relations from CSA 2
- Hypotheses on the dynamic development of actors, actions, resources, effects, including indications of impact, intensity, time behaviour and feedback from CSA 1 and CSA 2
- Higher Authority's and Commander's guidance
- Information requirements from other staff branches and non-military partners

- Hypotheses on the dynamic development of the system "operational environment" from experts, practitioners, planers and decision makers

3.2.3.3 CSA 3 Procedures

- Discuss options regarding the possible actions and strategies of relevant actors in the operational environment. These options should be based on commander's guidance, staff information requirements, experience from past observation of the operational environment, expert advice and the Systems Analysis work performed in prior steps. This discussion again is an iterative process involving experts, planners and deciders. The options may serve as stimuli for simulations of the operational environment
- The rationale for choosing the options for further analysis arises from discussions and the facts and instruments developed in steps CSA 1 and CSA 2. Argumentative links e. g. to causal loop diagrams, influence diagrams, taxonomies are established.
- Discuss the effects (including foreseen and unforeseen consequences) that the stimuli / execution of options trigger in the system "operational environment".
- Based on this discussion choose (or develop) simulations according to the criteria
  - approximation and validity
  - economy of time, handling, data provision
  - simulation technology
  - understandability and acceptance by relevant actors, clients

  with the aim to do the exploratory research of the operational environment
- Simulate to understand the impact of stimulus on selected actors while maintaining the position of other actors, in order to reduce confounding variables.
- Analyse the results of the simulation runs
- Develop an impact assessment of the tested stimuli / options. The assessment will include consideration of
  - intended (opportunity) or unintended (threat) outcomes,
  - probability of success and risk associated with each stimulus / option, and
  - variation in time of actor behavior based on each stimulus / option.
- Engage appropriate representatives from government organizations, IO, NGO, other private sector, academia, either directly or through a coordination function, in order to gain manifold/different points of view during the conduct of the procedures above.
- Compare this assessment with staffs and partners' projections of how *r*elevant actors may have reacted to the given stimuli
- Discuss the results of simulations with the staff, partners or the decision-maker and his/her staff to enhance understanding and operative background knowledge, answer information requirements, enable staff work, and facilitate decision-making
- Analyze and assess simulation results to further refine the models of the operational environment – mental models as well as simulation models, e. g. influence diagrams. Simulations show or emphasize failures in thinking the dynamics, overlooked feedbacks, time delays and non linearities. Refinement and enhancement is a consequence of the inherent adaptability and reflexivity of the CSA process.

3.2.3.4 CSA 3 Output

- Understanding of the dynamics, feedback, time delays, non-linearities of the system "operational environment" based on quantitative evaluation (simulation)
- Insights for the deciders and their staffs into possibilities and success probabilities of own future actions and strategies: strength, weaknesses, opportunities and threats

- Insights for the deciders and their staffs regarding possible and probable future behaviour of actors in the operational environment
- Refined, extended and better model family of the operational environment
- Refined causal loop diagrams, influence diagrams, other graphical representations of relations, causes and dynamics.

3.2.3.5 CSA 3 Staff Participation

- System Analysts
- M & S Officer
- Intelligence
- Representatives of supported organizations

3.2.4 Provision of Systems Analysis Updates (CSA 4)

3.2.4.1 CSA 4 Purpose

[32400] Purpose of CSA 4 is to communicate data, information, and knowledge acquired through Systems Analysis to the deciders, planners and their staffs. These updates may be routinous, periodic or on-call, they will strive to provide SA/SU and enable decision-making.

3.2.4.2 CSA 4 Input

- Insights from the Systems Analysis in steps CSA 1, 2 or 3 –"operative background knowledge"
- Usable and communicable models / simulations of the operational environment
- Representations and visualizations of results and arguments in the language of the relevant actors in the operational environment
- Questions and feedback from Commander, staff and other (non-military) actors

3.2.4.3 CSA 4 Procedures

- Translate and represent results of steps CSA 1 – 3 into the mode of thought of the actors / partners you communicate and collaborate with (experts, planners, deciders of military and non-military provenience)
- Provide updates and reports to the decision-maker and his/her staff to communicate data, information, and knowledge acquired through Systems Analysis
  - Updates and reports to the decision-maker should focus on enabling his/her decision-making
  - Updates and reports to the staff should focus on assisting in the genuine activities of the staff, in planning, execution and assessment, e.g. in the development of the Desired End State, CoA, and the assignment of resources
- Permanently interact with staffs / members and (if necessary or useful) members of other agencies, working groups, fora, committees, experts in order to further the Systems Analysis
- Receive questions and guidance for CSA.

3.2.4.4 CSA 4 Output

- Updates and reports to the decision-maker and his/her staff

- Permanent provision of “operative background knowledge” on the system “operational environment” through Systems Analysts to the decision-maker and staff
- On-call provision of “operative background knowledge” on the system “operational environment” through Systems Analysts to actors / partners deemed relevant by the decision-maker.

3.2.4.5 CSA 4 Staff Participation

- System Analysts
- Knowledge Information Management Officer.

3.3 Knowledge Processing (KP)

[33000] The Knowledge Processing (KP) activity consists of 3 sub-activities:

- Knowledge Request Management (KRM)
- Knowledge Acquisition (KA)
- Knowledge Integration (KI)

[33005] These sub-activities ensure the on-going development of the MN KB and are conducted continuously and in parallel. Whereas the creation and evolution of knowledge is done by the System Analysts during CSA or by other sources (e.g. Intelligence) connected to the KD process, identification, localization, exchange, and distribution of information and knowledge is mainly the business of Knowledge processing. It is done by the KB OpStaff.

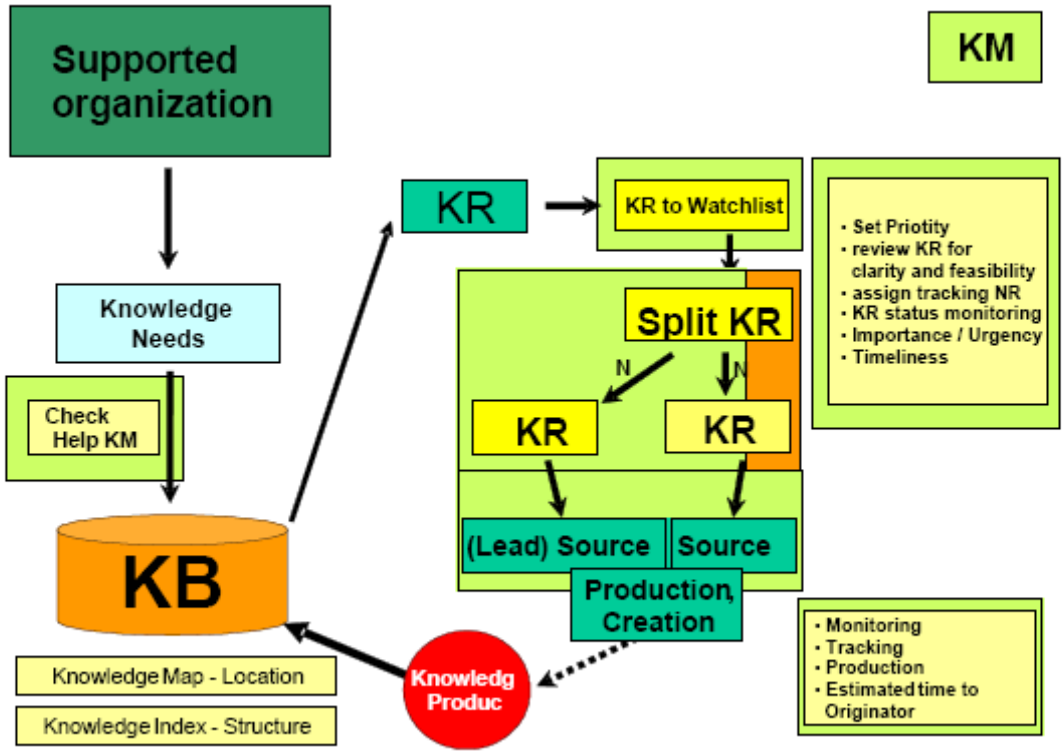

Figure 4: Knowledge Processing

3.3.1 Knowledge Request Management (KRM)

3.3.1.1 KRM Purpose

[33010] Purpose of KRM is to establish a user access mechanism and to generate new information and knowledge, which does not currently exist in the MN KB by tasking the KD staff elements to develop answers to KRs based on the content of the MN KB. KRM analyzes knowledge gaps and shortfalls of all customers involved. It uses the Knowledge Acquisition 2 step to identify required sources and continuously contributes to the Knowledge Integration steps during the overall KD process.

[33015] KRM is a cross sectional activity which involves KD and also the overall Knowledge Management functions. KRM has to assure the available knowledge production capabilities to be able to respond to the highest prioritized KRs.

3.3.1.2 KRM Input

- Specified knowledge requirements from the staff
- Formalized/standardized KR from any KM function
- KR list from KM function
- List of identified sources for answering KR from KA
- Input from CSA 2, CSA 3, CSA 4 (depending on KR)

3.3.1.3 KRM Procedures

- Search the MN KB for the information or knowledge required by the user (it is assumed that the originator will conduct an initial search, possibly with the assistance of a knowledge management element. If the search is unsuccessful a formal KR will be submitted)
- Initiate a formal KR by providing a standard format and electronic form for the user (knowledge management function)
- Receive the formalized/standardized KR as it has been generated and submitted (knowledge management function)
- Review the KR for clarity, accuracy, and completeness
- Assign a unique tracking number to each KR (knowledge management function)
- Assess, analyze, and prioritize the KR in conjunction with the customers goal system and other requirements
- Push KR to the identified sources
- Provide an expected time for answer (NLT) [11] to the originator and the(knowledge management function)
- Maintain a KR status page (knowledge management function)
- Receive the answer to the KR. The new data, information or knowledge has to be
  - integrated or stored in the MN KB (in layer1, layer2, or both), and
  - forwarded to the originator as a KR response.

3.3.1.4 KRM Output

- KR status page with prioritized KR and tracking number
- List of identified sources for answering KR
- Answers to KR according to prioritized KR list and notification to KR originator

[11] No Later Then

- Information and knowledge inputs to the MN KB

3.3.1.5 KRM Staff Participation

- KB OpStaff
- System Analysts
- KB users

3.3.2 Knowledge Acquisition (KA)

3.3.2.1 KA Purpose

[33020] Whereas the DKB steps create the initial MN KB and merge/integrate the data, information and knowledge from the coalition partners and other sources, the KA activity supports the sustainability and improvement of the MN KB in response to KRM.

[33025] The KA sub-activity will ensure that identified knowledge shortfalls or gaps are matched by the identification and connection of possible new sources. It will retrieve information and knowledge from reliable sources and present it to KI for integration. This information and knowledge may be classified or unclassified following the rules of MN Information Sharing.

[33030] Knowledge Acquisition as a continuous activity utilizes linkages created by existing knowledge management functions or creates new linkages as required.

[33035] KA identifies and adds appropriate new sources of information and knowledge according to System Analysts' and other processes' or projects' knowledge requirements and needs. It also retrieves required data, information, and knowledge from these sources.

3.3.2.2 KA Input

- List of information and knowledge requirements from KA
- List of presumable (near term) future information and knowledge requirements from KA
- Analyzed and prioritized KR from KRM

3.3.2.3 KA Procedures

- Identify appropriate new sources to meet the customers' requirements
- Determine and identify the best possible and appropriate source for an answer to a KR
- Contact the identified new source in close connection with existing knowledge management functions
- Validate the contacted new source in close connection with existing knowledge management functions
- Instruct existing knowledge management functions on how to connect the validated new source
- Connect identified new source (knowledge management function)
- Use linkages created by existing knowledge management functions or (when required) trigger existing knowledge management functions to create new linkages
- Gather required information and knowledge from any source available

3.3.2.4 KA Output

- Appropriate new sources added to MN KB (see KI 2)
- Identified sources to answer a KR to KRM

- Reliable information and knowledge
- Triggers for the creation of new information and knowledge linkages to KI sub activity

3.3.2.5 KA Staff Participation

- KB OpStaff
- System Analysts
- Supported organization representatives

3.3.3 Knowledge Integration (KI)

[33040] The Knowledge Integration sub-activity ensures the integrity of the new information or knowledge, its semantics (ensure that all input is properly assessed and integrated into the respective layers), the integrity of the architectural structure of the MN KB, and its continuous transaction.
Possible KB inputs may stem from various sources (e.g. KRM, other processes or projects, informal queries by any other actor involved).

[33045] KI consists of two discrete steps; however, they function in parallel and in a continuous manner throughout:

- Cultivation of KIndex/KMap (KI 1)
- Integration of MN KB inputs and of the inputs from all other available sources (KI 2)

3.3.3.1 Cultivation of KIndex/KMap (KI 1)

3.3.3.1.1 KI 1 Purpose

[33050] Purpose of KI 1 is to check up constantly and to further develop the KIndex and the KMap in order to provide a continuously updated overview of available information and knowledge. Also, it ensures the users ability to gain rapid access to the relevant and valid information and knowledge for the execution of their processes or projects.

[33055] The KIndex must allow multiple structures to be applied simultaneously. The purpose of that is e.g. to facilitate multiple views of the same information. Since the full spectrum of upcoming questions cannot be foreseen, the structure of the MN KB must be as flexible as possible and allow new structures and new views to be added when the need arises.

[33060] The KMap is the reference to the physical location (such as a DB[12], SME, CoE) where the knowledge and information resides.

3.3.3.1.2 KI 1 Input

- Initial KIndex and KMap from DKB 2
- MN KB from DKB 2
- New information and knowledge input by the connected sources via KA
- Answers to KR from KRM

[12] Data Base (DB)

3.3.3.1.3 KI 1 Procedures

- Receive new information and knowledge input from the connected sources, processes and projects
- Provide a constant update and further development of the KIndex and the KMap with regard to consistence, relevance and timeliness (versioning, in close connection with existing knowledge management functions) in order to provide a continuously updated overview of information and knowledge availability and residence

3.3.3.1.4 KI 1 Output

- Updated KIndex to KI 2
- Updated KMap to KI 2
- Inputs for the MN KB to KI 2
- Answer to KR to KI 2

3.3.3.1.5 KI 1 Staff Participation

- KB OpStaff
- System Analysts

3.3.3.2 Integration of MN KB Inputs (KI 2)

3.3.3.2.1 KI 2 Purpose

[33065] Purpose of KI 2 is to relate new data and information in order to integrate new knowledge products into the MN KB (step DKB 2). KI 2 is performed in permanent collaboration with the System Analysts. The elaboration partly follows the principles of traditional information processing: data and information are referenced, collated, evaluated, analyzed, integrated and put into usable form through required knowledge products. That includes clustering of relevant documents, translation, format conversion, linking relevant documents together, highlighting inconsistencies that need to be analyzed as well as assigning metadata to pieces of data and information.

3.3.3.2.2 KI 2 Input

- Updated KIndex from KI 1
- Updated KMap from KI 1
- Answers to KR from KRM
- Inputs for the MN KB including the continuous data, information or knowledge contributions from KI 1
- Appropriate new sources added to MN KB from KA 2

3.3.3.2.3 KI 2 Procedures

- Receive new information and knowledge input from connected sources, processes or projects
- Receive information provided by coalition nations coming from any level of an organizational hierarchy
- Classify, restructure, and translate information and knowledge input

- Register and evaluate MN KB inputs prior to pushing them to the MN KB in order to facilitate consistency and minimize redundancies in the MN KB content in continuous and close cooperation with the System Analysts. Additional national, alliance and other knowledge inputs will be reduced by transferring information and knowledge to the MN KB by
  - integrating raw data, information and assessments into agreed coalition knowledge,
  - integrating assessments gained through other intellectual processes, and
  - integrating actionable knowledge produced in support of the coalition decision-making process, using the Systems Approach.
- Reference, collate, evaluate, integrate and interpret correlated information and knowledge in close and continuous connection with the System Analysts as required and depending on the level of elaboration of the inputs
- Trigger KR if KI discovers discrepancies to create new knowledge or a new assessment
- Maintain linkage inside the KB in close cooperation with existing knowledge management functions

3.3.3.2.4 KI 2 Output

- KB inputs from national DBs and other sources
- KB input produced according to requirements posed by costumers
- New KR to KRM

3.3.3.2.5 KI 2 Staff Participation

- KB OpStaff
- System Analysts
- Sources of knowledge representatives (SME, CoE, Regional Advisor etc.)

4 Implementation of Knowledge Development

[40000] Implementation of KD into existing or emerging organizational structures can be realized in different ways. This document is not intended to provide a blueprint for its implementation. However, it defines basic ideas and minimum prerequisites and offers opportunities for further development steps which will bring up innovative ideas.

[40005] With regard to personnel and organizational structures it shall be underlined, that the following chapter provides ideas for an ideal personnel manning. Upon implementation, multinational/national authorities will have to decide, if existing structures cover the requirements for KD or new structures have to be created.

4.1 General Implementation Aspects

[41000] KD represents a new functionality based on a network of personnel, methods, processes and technologies. All involved actors facilitate the conduct of KD and contribute to the results. Not all involved personnel is military or military contractor. With regard to the extended network of SMEs, research institutes, governmental departments, IOs/NGOs and others involved, new ideas for integration have to be developed. Integration will not necessarily be realized in existing military structures only.

[41005] The enormous progress in information technologies offers abundant opportunities for alternative ways of networked and distributed activities. Collaboration tools and advanced communication systems effectively bridge the gap between distributed elements of collaborative networks in nearly real time and almost without limiting the quality of their work.

[41010] Performing KD requires flexible, capability oriented structures that will be tailored to the mission.

[41015] All elements involved in the performance of KD compose the KD Organization.

4.1.1 Generic Implementation Prerequisites

[41020] Implementation of KD requires a combination of KD functionality prior to the commencement of an operation as well as a concept for its mission oriented deployed execution. The operational context will finally dictate the structural design.

[41025] KD functionality support the decision-making process in advance of an operation and represent the core element for the rapid build-up of mission tailored structures.

[41030] Mission tailored structures are a networked, collaborative combination of in-theatre elements, reach back elements, and External Expert Networks.

[41035] Prerequisite for a networked KD Organization is a permanent availability of collaborative information space with standing, secure, and redundant high performance communication systems that link all elements.

4.2 Guidance for Implementation of Structures

[42000] This chapter is not intended to serve as a blueprint for the implementation of structures. However it provides generic ideas for their outline.

4.2.1 KD Functionality

[42005] KD is a functionality that must be permanently available, independently of a concrete mission or operation. The different elements of KD create the prerequisites for an

undelayed knowledge-centric support of the decision-making process in advance of and during an operation. They will enable the quick build-up of mission-tailored KD structures.

4.2.1.1 General Functions

[42015] KD has to advice decision makers whenever required and is fully integrated into contingency and mission planning. It permanently monitors areas of interest, where the commencement of a future operation can be anticipated.

[42016] KD identifies relevant sources of information and provides (for) their accessibility. Thereby it establishes and maintains relations to appropriate external organizations, SME and CoE, IO, NGO, RA and Nation Representatives.

[42017] KD is responsible for the steady generation of analytic expertise and the further development of methods, procedures and technologies.

[42018] It develops and establishes exchange procedures for classified and unclassified data.

4.2.2 Mission Tailored Structures

[42025] Mission tailored structures will be established to perform KD in operations. They are based on permanent KD functionality and will be composed of deployable in-theatre elements (Forward Element, FE) as well as reach back elements (Reach Back, RB).

[42025] Both capabilities

- perform the same functions, but with partly different or complementary sources of information and different depth of analysis,
- will be tailored depending on their corresponding locations' conditions (close to customers, technical equipment, structural implementation, availability of expertise, etc),
- contribute to and share a common knowledge base, and
- demand close cooperation, synchronization, and connection , both with each other and with other staff elements[13].

4.2.2.1 Forward Element

[42035] Conduct of KD in an operation requires in-theatre elements (FE) collocated with the respective supported organization. The FE is fully integrated into the operational planning process and has full visibility to the commander and staff.

[42040] FE will be linked with other elements of the KD organization via CIE.

[42045] In doing the same type of analysis as the RB, FE in close coordination with the customer will focus and tailor its analysis process and products to the needs of the decision making process.

[42050] FE synchronizes with the staff battle rhythm.

[42055] FE should have full and unhindered access to all in-theatre information sources. It establishes its own liaisions and merges their products into the comprehensive KB.

[42060] Other than the RB, FE focuses on quick response products and the refinement of products pre-modelled by RB.

[13] NATO Bi-Strategic Command, Pre-Doctrine Handbook

[42061] Manning and equipment of FE have to be flexibly balanced with the footprint limitations in theatre.

[42062] Within the responsibility of the FE are functional control and coordination of KD activities, central authority for collection and processing of all inputs from all sources of information and central authority for approval of results of KD.

4.2.2.2 Reach Back Element

[42065] In slight contrary to the FE, RB conducts a more comprehensive and in-depth analysis, based on a broader spectrum of information and knowledge, and goes into greater detail.

[42070] RB is focusing on analysis fidelity, broad band expertise and responsiveness, relying on dedicated background information and analysis.

[42075] RB is working in close synchronization with the in-theatre KD (FE).

[42080] The structure of RB is determined by appropriate multinational and national authorities. Troop contributing nations will fill positions and provide support and assets on a case-by-case basis or as per general.

4.2.3 External Expert Network

[42100] The External Expert Network contributes to the KD Process in all structures. It is not a fixed, institutionalized construct. Moreover, its elements will be consulted whenever necessary based on a cooperative relationship. It covers the whole spectrum of external sources with relevance for KD across the whole spectrum of interest.

4.3 Roles and Responsibilities of Personnel

[43000] The entire KD Organization is always mission-tailored. This document provides an overview of key personnel directly involved in the Systems Analysis. Consequently it will not cover technicians and other personnel not directly involved in Systems Analysis.

[43005] As this generic document provides only an overview of capabilities, detailed training requirements for personnel directly involved in Systems Analysis will be provided with job descriptions. However, familiarity with the Systems Approach is desired for all personnel serving in the supported organization.

4.3.1 Knowledge Development Chief

4.3.1.1 Job Description and Responsibilities

[43010] The KD Chief is the head of the KD Organization. He/she is primary point of contact for all KD matters from outside the KD section and provides directives, priorities, and guidance for the KD process and KD elements based on his/her mission analysis. Thus he/she defines requirements for the collection of KD relevant information in close cooperation with J2 and the Info-Ops Chief and provides guidance for the analysis itself. As an integral part of the supported organizations staff he/she is integrated in their efforts. Consequently he/she can determine their specific knowledge needs and transform them into guidance for the analysis process. His/her ability to anticipate questions and requirements that may arise on the customer side provides long term guidance for KD. In close dialogue with the decision makers he/she keeps them aware of possible actions to achieve effects in the operational environment including desired and undesired consequences. Automatic,

proactive tasking may emerge within the context of the KD process, its results and the interaction with operation, planning, execution and assessment.

[43015] The KD Chief should be posted with the highest decision level (commanding person or decision board) of the organization KD is embedded in. He/she provides final advisory service to this level. During a mission he/she is located with the Forward Element.

[43020] The KD Chief executes functional command over the KD Organization. He/she coordinates the analysts efforts with regard to information collection and analysis work. Within the KD section, he/she supervises the product validation process and is the last authority to release products.

[43025] The KD Chief manages the KD relevant interaction, planning and coordination between the KD elements, all other (HQ or e.g. Forum) staff functions and other actors involved. He/she ensures the integration of the Systems Analysis results across all staff functions and other elements involved. His/her responsibility includes detection of knowledge gaps and the development of an information collection strategy. This may include a close cooperation with the Intel function and the articulation of requirements for the information collection plan.

[43030] The KD Chief supervises information-sharing activities and requirements concerning the results of KD. He/she coordinates the build-up and maintenance of the External Expert Network and participates in the assembly of inter-agency linkages for information exchange. He/she is supported resp. escorted by KD SysA, if appropriate or necessary. He/she is the primary point of contact for the External Expert Network and other actors involved outside the supported structures. He/she initiates and continues multinational and interagency information sharing activities and the multinational distributed collaboration between HQ staff and reach-back capabilities. Information exchange and review of other actors' knowledge is an important prerequisite for the internal product validation process.

4.3.1.2 Required Qualification

[43035] Qualification requirements include, but are not limited to:

- Demonstrated leadership and management abilities
- Command and Staff College graduate or equivalent training
- Masters Degree in natural science, social sciences or engineering
- Experience in MN integrated staff work
- Profound knowledge of concepts, processes and methods of operation
- Analyst background, especially experience in Systems Analysis and interdisciplinary
- Fair knowledge of all relevant tools and technologies

4.3.2 System Analysts

4.3.2.1 Job Description and Responsibilities

[43040] The System Analyst is responsible for the holistic analysis of the focus area. He/she is a generalist more than a specialist in a respective analysis domain. He/she cooperates with elements of the External Expert Network and other components of operation, such as intelligence or logistics, other assisting services, including governmental as well as non governmental actors. He/she is located where appropriate, in the Forward Element as well as in the Reach Back Element.

[43045] The System Analyst exploits all sources of information and conducts analysis and assessment within the area of interest. He/she works in an integrated analysis team, thus contributing to the integrated analysis of the entire system. In accordance with the analysis plan he/she is responsible for the research and handling of specific information within his/her team.

[43050] The System Analyst provides the direct link to the External Expert Network and integrates their specific expertise. In a continuous dialogue between all actors involved he/she compares his/her results with those of others, thus contributing to the internal product validation process. The verification of information sources based on reliability, probability and likeliness as conducted by the System Analyst is an important prerequisite for valid results.

[43055] A special subset of the System Analysts mission is that of the direct advisor to other staff elements. As an integral part of the supported organization he/she has a fair knowledge of respective concepts, processes and methods of operation.

[43060] Closely involved in the staff work, he/she is e.g. in a permanent dialogue with the planners and anticipates arising questions and knowledge needs. This dialogue also helps him/her to identify knowledge gaps and develop requirements for the collection of information. He/she proactively provides analysis results to the operational personnel and assists them in the development of CoA. He/She offers valid predictions of future system's behaviour based on Systems Analysis and M & S results.

[43065] Within the respective organization he/she is the primary point of contact on the working level for all KD related topics. He/she integrates knowledge, products, and contributions from other staff components and other actors into the KD process. He/she supports the KD Chief to initiate and continue information collection and sharing activities as well as the multinational distributed collaboration between supported organizations HQ, KD Organization and other actors involved.

[43070] The System Analyst provides the direct link to M & S section within KD. He/she defines simulation needs for the evaluation of systems dynamics as well as trend analysis and advises the operational personnel when, where and how to use M & S. He/she develops proposals for situation oriented simulation runs and articulates requirements and defines the simulation scenario including assumptions, variables, time horizon, and framework. He/she will interpret the simulation results in a close dialogue with e.g. planners and integrate them into the staff work.

4.3.3 Required Qualification

[43075] Qualification requirements include, but are not limited to:

- Demonstrated leadership and management abilities
- Masters Degree in natural science, social sciences or engineering
- Experience in MN integrated staff work on desk officer level
- Fair knowledge of concepts, processes and methods of operation
- Profound knowledge of analysis methods, especially systems analysis
- Experience in interdisciplinary work
- Profound knowledge of capabilities and limits of M & S
- Profound knowledge of all relevant tools and technologies

4.3.4 KB Operational Staff (KB OpStaff)

4.3.4.1 Job Description and Responsibilities

KB OpStaff is responsible for the Development of the Knowledge Base (DKB) and Knowledge Processing (KP), including Knowledge Request Management (KRM), Knowledge Acquisition (KA) and Knowledge Integration (KI); their task is coherent technical management and administration.

KB OpStaff is in charge of the internal knowledge management and operates the interface to the external information management system.

KB OpStaff assists in establishing information exchange procedures with all actors involved and by providing a platform for information exchange including a proper handling of classified data.

KB OpStaff operates KR management forwarded to KD. They collect these requests and process them in the information collection strategy or provide hints where this information is already available. They supervise the flow of respective requests, ensure their timely processing and invigilate their final answer.

During KA the KB OpStaff performs a long term or steady state input to supports the sustainability and improvement of the MN KB in response to KRM. KB OpStaff ensures the integrity of the MN KB, its architectural structure, its semantics and its continuous transactions during KI.

KB OpStaff supports the preparation of the MN KB (DKB 1) by performing a discrepancy analysis in order to identify the divergent nation and alliance assessments and a selection of critical discrepancies to be solved.

KB OpStaff supports the building the Multinational Knowledge Base (DKB 2) by transfering the available data, information and knowledge from the national, alliance and other Knowledge (Bases) into the MN KB including the complete elimination of duplications and redundancies and the check of reliability in close cooperation with the CSA activity. They store all the inputs into a structured data file and make it accessible for the System Analyst.

4.3.4.2 Required Qualifications

Required qualifications include, but are not limited to:

- Management abilities and profound IT skills
- Capability to operate all relevant tools and technologies
- Knowledge of methods of Systems Analysis

4.3.5 Foreign Disclosure Officer (FDO)

The FDO is the central authority for the release of KD products. He/she establishes and maintains business rules and a disclosure policy for the release of KD products based on the respective release policies of knowledge providers and operation security needs.

Required qualifications include, but are not limited to:

- Expertise in IT security issues as well as release and disclosure policies.

- Fair knowledge of concepts, processes, and methods of operation, and especially Knowledge Management,

4.3.6 Modelling & Simulation Capability

M & S is an important part of / tool for Systems Analysis. The KD personal must be able to understand, handle and generate models and simulations.

4.3.6.1 M & S Functionality

[43082] Depending on problem, context, "battle rhythm" personnel must be able to tackle the following questions concerning simulation:

- Under which circumstances is which simulation appropriate?
- What are the data requirements for a simulation?
- What are the time requirements for simulation runs and analysis?
- How have the results to be interpreted and validated?

[43083] There must be the capability to run simulations, analyze results and discuss these results with the other system analysts, with experts and customers.

4.3.7 Knowledge Development Technical Personnel

[43130] A staff of technical personnel is required to operate the KD related tools and technologies. This includes the collaborative information space but excludes Command and Control for the connectivity between Forward Element, Reach Back Element, and other actors involved. This is subject to the supported organization's responsibility.

4.4 Procedures

[44000] Procedures and Business Rules are subject to Standing Operating Procedures (SOP). They will not be addressed in this generic document.

4.4.1 Integration of Knowledge Development

[44005] KD can be integrated as a new function amongst others into standing or emerging Staff structures. In this case it should be located at the same level as other supporting functions. KD then reports directly to the COS. KD can also be performed by existing elements. In this case existing structures would adopt the methodology and perform KD. Details are subject to respective SOP.

4.4.2 Position in Battle Rhythm

[44010] The battle rhythm for the KD-Systems Analysis section or personnel is dependent on, and must be integrated within the headquarters staff organization, operational mission, process, and commander's preference. Systems Analysis by its nature is focused on plans and predictive assessment indicators to a greater degree than on current operations or execution.

4.4.3 Security

[44015] The protection of the KD information space and the process itself is subject to existing procedures and methods. Details will not be addressed in this generic document.

[44020] The KD process requires permanent access to the MN KB as repository where knowledge can be stored and information can be retrieved. The value of the MN KB

depends on the correctness, actuality and reliability of its contents. Therefore confidentiality, integrity and availability need to be preserved.

[44025] Means to ensure this are failover, access control and version control. The corresponding requirements are effective authentication mechanisms that control the access to information, versioning mechanisms that enable to control and trace any change applied to the information and the existence of an availability management that provides repair and redundancy mechanisms. The overall architecture of the technical environment, in which the MN KB is operated, has to provide these mechanisms. Any technical solution has to be supplemented by suitable business rules.

[44030] The implementation of access control has to support the activities related to DKB. It should reflect the roles and responsibilities of personnel as defined by the concept.

[44035] The MN KB will be accessible via computer network. Its physical structure has to be in accordance with any regulations due to classification of the contents of the MN KB.

4.5 Technologies

[45000] A suite of tools and technologies should support the KD process. The central requirements are intuitive use and integration into existing or emerging processes for KD. The process is always the driving factor for design and selection of tools.

[45005] Due to ever-changing operational requirements KD is challenged by the absence of universally accepted information integration and exchange standards as well as knowledge and information models.

[45010] The technologies that support KD must be flexible enough to be customized to short and midterm operational architectures, their organization, systems and information requirements. Therefore the selected technology has to be platform independent, well understood and widely accepted. KD requires:

- An architecture that prescribes standards and guidelines for interfaces, technologies and information exchange which supports flexible and modular knowledge provision that can be used by human beings as well as by computers,
- basic services for communication, collaboration, archiving, knowledge retrieval, storage, publishing and subscription of knowledge in a decentralized environment,
- analysis and research tools with an interoperability to efficiently support the CSA process,
- a secure environment including guaranteed availability, integrity, confidentiality of information.

[45015] Concepts developed and furthered by internationally accepted standards can support the design of the architecture, especially through

- scalability and decentralisation of information,
- separation of form and content,
- the existence of universal standards for adressing information resources,
- the use of standardized information exchange protocols,
- the use of a common syntax,
- semantic standards that enable computers to associate data with meaning,
- the use of an service-oriented approach.

[45020] The architecture has to reflect given security policies at all technology levels, e.g. protocols, browser user interfaces, identity management, secure metadata, encryption and key management.

5 References

XXXX

6 Glossary

CONTINUOUS SYSTEMS ANALYSIS (CSA)
CSA is a subprocess of KD, conducted by Systems Analysts. It provides a holistic view on a system, its subsystems and elements, their relations, interactions, their dynamics and possible development over time.
CSA is made up of 4 steps (Examine the operational environment – model the operational environement – examine and simulate possible future system behaviour - provide System Analysis updates for the supported organisation). These steps will be passed through iteratively, including skipping a step as well as branching back to a former step.

DEVELOPMENT OF THE (MULTINATIONAL) KB (DKB)
DKB is a subprocess of KD. It is conducted by the Knowledge Manager (KM) and supported by the System Analysts. Purpose of DKB is to provide the necessary technical, organisational and administrative prerequisites for an implementation of the (MN) KB, to transfer the available data, information and knowledge from all underlying sources and KBs in it (without redundancy and duplications) and to ensure and manage the user's access to the required data, information and knowledge

INFORMATION
In the KD context Information is related to concepts like communication, control, data, instruction, knowledge, perception and representation. Overall seen, information is the result of processing, manipulating and organizing data in a way that adds to the knowledge of the person or institution receiving it.

INFORMATION MANAGEMENT
Information Management is the collection and management of information from one or more sources and the distribution of that information to one or more audiences. This sometimes involves those who have a stake in, or a right to that information. Management means the organization of and control over the structure, processing and delivery of information.

INTELLIGENCE
In the KD context Intelligence means the gathering, classification and evaluation of all aspects of information concerning foreign nations, forces or areas assessed to be hostile or potentially hostile or to be relevant for own actual or potential operations.

INSTRUMENTS OF INFLUENCE
Means for use by any actor to affect others' perceptions and attitudes favourable to own objectives.

KNOWLEDGE
Knowledge in the context of Knowledge Development is the apprehension of the existence, composition, context, functionality and affectability of real or abstract objects of attention, concern, or interest. Knowledge is generated through the development of mental patterns and conceptual models of the perceived reality; it is derived from the realization of inherent structures and correlations by deliberate abstraction, and is influenced by experience,

education, socialization and enculturation.
Knowledge is inherently human, implicit or tacit; it can only partially be made explicit, fully
revealed or expressed without vagueness. Knowledge can be applied consciously as well as subliminally. It enables the projection of developments and provides the primary basis for subsequent decision-making and performance (behaviour and action).

KNOWLEDGE BASE (KB)
KB is a networked repository that contains the results from Systems Analysis of the operational environment. It consists of implicit and explicit knowledge: the inherent knowledge of the systems analysts and the products, which represent that knowledge. Contents of the Knowledge Base are made available to the customers (civil and military actors and their supporting staff) by methods of Knowledge Management and personal advice provided by the systems analysts themselves.

KNOWLEDGE DEVELOPMENT (KD)
KD is the integration of isolated data into a useable body of information and relationships. KD supports planning, execution and assessment by providing a holistic view of the engagement space. Systems Analysis is a specialized portion of KD which attempts to provide a comprehensive understanding of the Political, Military, Economic, Social, Infrastructure, and Information (PMESII) domains and how they interact as a system of systems within the engagement space. This understanding helps to identify the most effective Political, Military, Civil and Economic instruments available to achieve the desired effects. KD is a continuous, adaptive, and networked activity that relies on trained and experienced experts.
Seen as a process, KD consists if three major subprocesses:
- Development of the (Multinational) KB (DKB)
- Continuous Systems Analysis (CSA)
- Knowledge Processing (KP)

KNOWLEDGE PROCESSING (KP)
KP is a subprocess of KD, conducted by the Knowledge Information Management officer, driven by users and System Analysts. Its purpose is to ensure the on-going development of the (MN) KB. KP comprises the subprocesses Knowledge Request Management, Knowledge Acquisition and Knowledge Integration.

MODEL
A model in the KD context is a theoretical construct representing parts of the operational environment. Models are abstractions and idealizations of real systems. There is a wide variety of types of models; e.g. mental models (,a person's cognitive representation of an idea or thought process), process models (,a schematic and documented representation of the single steps of a process, their interdependences and sequence in time, possible actions of the involved actors and their effects), mathematical models (,an abstract model that uses mathematical language) or computer models (,a computer program which attempts to simulate an abstract model of a particular system) and many more.
There are models for many aspects concerning an operational environment, among others:

- human behavior and how to control it
- social structures and relations and how to influence them
- economic structures and developments and how to bias them
- political developments and how to control them
- execution of operations (by military, police or other actors) and resulting effects

etc.[14]

OBJECTIVE FUNCTION

An Objective Function serves as assessment of different alternatives from a state space. The concept originates from (mathematical) optimization theory. The Objective Function assigns one or more numerical values to every alternative and enables so the comparison of different alternatives (better or worse). Formally, a space A of alternatives and a function

$$f: A \rightarrow R$$

are given, where R denotes the space of numerical values (one- or more-dimensional). Depending on whether R is a one- or more-dimensional space, f is said to be a **Scalar** or **Multi-valued Objective Function**, resp.
Generally, the state space A is assumed to own a certain mathematically defined structure. Normally, this is a vector space structure (where the operations of addition and scalar-multiplication are defined). A **Linear Objective Function** f features the properties

$$\mathbf{f(a + b) = f(a) + f(b)} \quad \textbf{(Additivity)}$$

$$\mathbf{f(\alpha \bullet a) = \alpha \bullet f(a)} \quad \textbf{(Homogeneity).}$$

Whenever A is a real vector space, every linear Objective Function is of the type

$$\mathbf{f(x_1, \ldots, x_n) = c_1 x_1 + \ldots + c_n x_n}$$

Every Objective Function not of this type is called a **Non-linear Objective Function**. A simple example for a Non-linear Objective Function is the distance of an object from the origin of a coordinate system

$$\mathbf{f(x_1, \ldots, x_n) = \sqrt{x_1^2 + \ldots + x_n^2}} \quad .$$

The function is homogeneous but not additive.

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[14] Following Herbert Stachowiak (1973) the concept of a Model is characterized by three features:

1. Mapping. A model is always a mapping of something; a representation of natural or artificial originals, which themselves can be models.
2. Limitation. A model does not cover all attributes of the originals, but only those which seem to be relevant for he model builder or model user
3. Pragmatism. Pragmatism means orientation towards usefulness. A model is not a priori allocated to an original. The allocation is relativized by questioning „to whom?“, „why?“ and “what for?”. The model builder or model user will apply a model during a restricted period and with a prearranged intention. This means, that every model is an interpreted one.

PMESII
The 'PMESII' construct is one way to structure the operational environment pursuant to the political, military, economic, social, infrastructural and informations domains. These domains mustn't be regarded as separate areas, but as multiply connected and interacting mutually.

SIMULATION
Simulation is the imitation of some real thing, state of affairs, model or process. The act of simulating something generally entails representing certain key characteristics or behaviours of a selected physical or abstract system. In the KD context we will here restrict on computer simulations. This may cover the numerical solution of a well structured system of differential equations from a mathematical model of a dynamic system (e.q. based on an Influence diagram) as well as a complex event driven and stochastic simulation of a strong interacting system (e.g. a battle simulation).
Simulations may be used for training an education as well as for studies and analysis. Simulations are to be used, when a experiment with a real (physical) system would be too costly or wasteful, or too dangerous or ethically not justifiable or lead to a irreversible status change for the system of interest.

SITUATIONAL AWARENESS AND UNDERSTANDING (SA/SU)
SA/SU is the human *perception* of the elements of the operational environment within a volume of time and space, the *comprehension* of their meaning, and the *projection* of their status in the near future.
Improved Situational Awareness and Understanding evolves from Knowledge Development and Knowledge Management.
In order to provide a common basis for analysis, planning, execution and assessment of operations, including their related processes and structures, shared Situational Awareness and Understanding needs to be developed.

SUBJECT MATTER EXPERT (SME)
SMEs are persons with extensive background knowledge and comprehensive experience in some of the relevant topics of the operational environment. SMEs can be military personal and military contractors, but may also be members of governmental departments, research institutes, GOs/NGOs or other institutions.

SYSTEM
A 'system' in the context of Knowledge Development consists of interrelated components/ elements constituting a combined and dynamic entity. A system may consist of systems again, called 'subsystems'. 'System elements' are subsystems not further decomposed for the purpose of analysis. Thus, the designation of a system as a system, subsystem, or system element depends upon the analytical viewpoint and level of abstraction.

SYSTEMS ANALYSIS

Systems Analysis is a method which defines a network of elements, their relations and interactions, evolving in space and time and so allows a valid contextual assessment of objectives, sequences of effects and sequences of actions. The result of Systems Analysis is a comprehensive modelling of the operational environment with its system dynamics and feedback loops. Systems Analysis will provide a description of intended effects and will expose both intended and unintended consequences.

UNCERTAINTY

In the context of decision making within a system it is rather the normal than the exceptional case that the base for the decisions is weak information / knowledge about the initial state and the dynamics of the concerning system. The weakness has to be seen in incomplete, divergent or contradictory information resulting in uncertainty of the decision makers about the effects of decisions. This is the starting point for theoretical considerations, how to handle uncertainty. The obvious approach to the problem is, whether it is possible to find a quantification of uncertainty. Although a measure can not always be assigned in an appropriate way, it facilitates the analysis in many situations. Normally, the quantification is done by assigning probabilities to different alternatives. In Mathematical Probability Theory this is a series of nonnegative numbers (weights) associated with the alternatives, summing up to 1. This means that the set of alternatives exhausts all potential states and each number is the probability of the occurrence of a specific alternative. Aside from mathematical theory there is no unique understanding of the concept of probability. In the context of frequency analysis the mental image of probability is that of the outcome of a random process. In the Bayesian approach it is rather that of subjective beliefs which can be the result of statistical analysis as well as personal judgement or intuition.

The probability concept is not directly related to effects of decisions (for instance costs) and should not be mixed up the concept of risk. This concept concerns the assessment of the effect of a decision under uncertainty and can be a qualitative as well as a quantitative measure. The probability of a certain outcome may be very small; nevertheless, the risk may be very high due to achieving an irreversible state of the system or enormous costs. The risk concept is often associated with an underlying probability space being the state space of a random process and a decision space (set of alternatives). Starting from a certain state a decision causes the change of the state of the system. The risk is a function assigning a value to each state and decision. In this context, it is convenient and makes sense to talk about average, probable, minimum or maximum risk, if decision makers envisage an uncertain state.

Decision Theory is concerned with the question, what are optimal decisions in a certain sense. Bayesian Decision Theory[15] assumes a known probability distribution on the state space and focuses on decisions minimizing the average risk. Since this cannot be assumed generally, other concepts have been developed taking the absence of an identifiable probability distribution into account. One of these concepts is that of Minimax Decisions inspired by ideas from Game Theory[16] and Statistical Decision Theory[17]. The theory is

[15] Sven Ove Hansson (2005), Decision Theory: A Brief Introduction, Stockholm, Royal Institute of Technology (KTH)

[16] Morgenstern, Oskar and John von Neumann (1947) The Theory of Games and Economic Behavior Princeton University Press

sometimes denoted by theory of games against (a willful) nature. In this concept decision makers assume a least favourable distribution on the state space (maximizing the minimum risk of decisions) and decide for actions minimizing the average risk with regard to this distribution, in other words, they minimize the maximum risk. In this way, such decisions are optimal for situations of unknown probability distributions on the state space.

Nash, John (1951) "Non-Cooperative Games" The Annals of Mathematics 54(2):286-295.

[17] A. Wald (1950), Statistical decision functions. New York, Wiley.

7 Abbreviations

A

B

BDA	Battle Damage Assessment

C

CA	Campaign Assessment
CD&E	Concept Development & Experimentation
CEA	Campaign Effectiveness Assessment
CG	Command Group
CIMIC	Civil Military Co-Operation
CIE	Collaborative Information Environment
CIS	
CoA	Courses of Action
COE	Center of Excellence
CoG	Center of Gravity
CONOPS	Concept of Operations
CoS	Chief of Staff
CROP	Common Relevant Operational Picture
CSA	Continous Systems Analysis

D

DB	Data Base
DIME	Diplomacy, Information, Military, Economy
DKB	Development Knowledge Base

F

FDO	Foreign Disclosure Officer
FE	Forward Element

G

GO	Governmental Organisation

H

HQ	Headquarters

I

IO	International Organisation

K

KA	Knowledge Acquisition
KB	Knowledge Base
KB OpStaff	Knowledge Base Operational Staff
KD	Knowledge Development
KI	Knowledge Integration

KIM	Knowledge-Information Manager
KP	Knowledge Process
KR	Knowledge Request
KRM	Knowledge Request Management

L

LEGAT	Legal Advisor

M

M&S	Modelling and Simulation
MN	Multinational
MN KB	Multinational Knowledge Base

N

NATO	North Atlantic Treaty Organisation
NGO	Non-Governmental Organisation
NLT	No Later Than

P

PMESII	Politics, Military, Economy, Social, Information, Infrastructure
POLAD	Political Advisor

R

RA	Regional Advisor
RB	Reach Back

S

SA/SU	System Awareness / System Understanding
SME	Subject Matter expert
SysA	System Analyst

W

WMD	Weapons of Mass Destruction